

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: GAECHTER, Jean-Pierre

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ART UNIT: 3682

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EXAMINER: Pilkington, J.

TITLE: MECHANICAL ACTUATOR INCLUDING A HELICAL-CAM NUT

Amendment C: REMARKS

Upon entry of the present amendments, previous Claims 37 - 52 have been canceled and new Claims 53 - 66 substituted therefor. Claims 1-36 were canceled in previous amendments. Reconsideration of the rejections, in light of the forgoing amendments and present remarks, is respectfully requested. The present amendments have been entered for the purpose of further distinguishing the present invention from the prior art.

In the Office Action, it was indicated that Claims 37 - 43 and 45 - 47 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Hogan patent in view of the Brusasco patent and the Barrett patent. Claim 44 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the Hogan patent in view of the Brusasco patent. Claim 48 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the Hogan patent in view of the Brusasco patent, the Barrett patent, and further in view of the Gould patent. Claim 49 was rejected under 35 U.S.C. § 103(a) as being unpatentable over the Hogan patent in view of the Brusasco patent, the Barrett patent, Gould patent and further in view of the Deveni patent. Claim 50 was rejected as being obvious over the Hogan patent in view of the Brusasco patent and the Barrett patent and further in view of the Halasy-Wimmer publication. Claim 51 was rejected as being obvious over the Hogan patent in view of the Brusasco patent and the Barrett patent and further in view of the Yaple patent. Claim 52 was

rejected as being obvious over the Hogan patent in view of the Brusasco patent and the Barrett patent and further in view of the Laskey patent. There was also an objection under 35 U.S.C. § 112, second paragraph for indefiniteness caused by a typographical error in independent Claim 37.

As an overview to the present reply, Applicant has revised the previous independent Claim 37 in the form of new independent Claim 53. New independent Claim 53 expresses the limitations of previous independent Claim 37 and includes the limitations that the outer tubular body has a “grooved” helical ball race “formed on an inner surface thereof”. Also, the indefinite phrase “a pro of” has been removed. This appears to have been a typographical error.

Importantly, in the present invention, it is necessary that the plurality of balls are received between the helical ball race and an inner surface of the outer tubular body. This inner surface of the outer tubular body has a “grooved” helical ball race that is suitable for guiding the plurality of balls. Applicant respectfully contends that the prior art combination fails to show this feature and does not carry out the functions nor achieve the advantages of the present invention.

The primary reference for the rejection of the present claim language was found in the Hogan patent. According to the Examiner, the Hogan patent discloses that the “inner face of the first tubular body comprises helical ball-races for guiding the balls” (see page 4, line 8 of the Official Action). Additionally, the Examiner has indicated that “the helical ball races in the inner surface of the outer tubular body are formed by a plastic distortion of said plurality of balls (balls press against inner side of outer tube)” (see page 5, line 11 of the Official Action). Furthermore, it has been indicated that the Hogan patent does not disclose the helical races that are formed on the inner surface of the outer member (see page 12, line 14 of the Official Action). Additionally, it is indicated that the Hogan patent “does not disclose a set pitch in the groove created by the plastic formation

between the inner wall and the balls" (see page 12, line 20 of the Official Action). In the Hogan patent, the balls are subjected to a radial load which presses the balls against the inner wall of the outer tube so as to cause a plastic deformation in the wall of the tube (see page 13, line 12 of the Official Action). Applicant respectfully disagrees with the Examiner's analysis.

Fundamentally, the Hogan patent shows that the outer tubular member has a "smooth internal wall" of a uniform diameter. This was found in column 2, lines 34 - 39 as follows:

The driven member 34 is formed with a smooth internal wall of a uniform diameter having closely fitted therein the two terminal washers 31 and 32, which act as sliding bearings for the sleeve to maintain it coaxially with the driving member 22.

Additionally, the balls are recited as being in frictional engagement with the smooth inner wall of the driving member. This was found in column 2, lines 53 - 56 as follows:

Each track 37 is filled with balls 38, extending less than halfway into the track and projecting radially therefrom into frictional engagement with the smooth inner wall of the driven member 34.

As such, it can be seen that the driven member (i.e., the outer tube) is smooth on an inner surface thereof and does not include any grooves, as recited in independent Claim 53.

In the Hogan patent, the operation of the device is described in column 2, lines 64 - 71 as follows:

In the installation of the device, care must be exercised to always provide an axial clearance between the adjacent faces of the disks 28 so that the axial thrust exerted on the disks by the spring means 33 will always subject the balls 38 to a radial thrust against the inner wall of the driven member 34, the extent of which is adjustable by varying the compression of the spring means 33 through the nut 24.

This operation was described further in the Hogan patent in columns 2 and 3, lines 71 - 5 as follows:

As rotation is imparted to the driving member 22 and consequently to the disks 28 and the disks 29 and 30; the balls 28 rotating within their respective helical tracks 37 will, for each revolution of the driving member 22, move axially an extent equal to the pitch of the helix of the tracks, which axial movement is transmitted to the driven member 34 by frictional engagement of the balls therewith.

As can be seen, in the Hogan patent, it is specified that the movement is transmitted to the driven member only by frictional engagement of the balls with that driven member. Moreover, the ball friction drive of the Hogan patent utilizes a means to adjust the thrust against the inner wall. If the drive of the Hogan patent utilizes such an adjusting means, it is precisely to permit a transmission of the movement through friction engagement only and absolutely not for deforming the wall of the outer tube. These adjusting means are utilized so as to avoid such a wall deformation, as suggested by the Examiner.

It is further clear in the Hogan patent that there is no “plastic deformation” of the inner wall of the outer tube. In particular, in column 4, lines 10 - 19 as follows:

In practice, material hardness of the operative elements is to be as great as conveniently possible with the usual heat treating practices, thereby limiting the rolling friction of the balls within their tracks to a minimum, which friction, of course, must be overcome by sufficient driving power of the power source. The sliding friction resulting from the radial thrust of the balls against the driven member is, of course, greater than the rolling friction, thereby enabling traction without slippage of the balls with the driven member to transmit linear motion thereto.

As such, it can be seen that the operative elements of the drive system of the Hogan patent are formed of a very hard material in order to permit sliding friction and to limit the rolling friction of the balls. In this way, the movement of the driven member is generating by tracking this driven member without slippage of the balls. Additionally, the very hard material used for the operative

elements of this drive specifically strongly excludes any plastic deformation that could be caused by the pressing of the balls. As such, the analysis of the Examiner that the grooved inner surface of the outer tubular member being caused by this plastic deformation is completely contrary to the teachings of the Hogan patent.

Applicant respectfully contends that the formation of the grooved helical ball races in the inner surface of the outer tubular body is clearly patentably distinguishable from the prior art combination. First, it is recited in the Hogan patent in column 1, lines 20 - 35, that:

In ball screw and nut mechanisms as well as in the conventional screw and nut constructions, the rate of axial travel of one of the members for a given rotary speed of the other is primarily governed by the pitch of the helical ball channels or screw threads respectively. In the case of ball screw and nut, the pitch of the helical ball channel is limited by the size of the balls, and in the conventional screw and nut construction the pitch of the thread is limited by the size of the screw threads required to carry the intended load. Thus, when axial motion of one of the members is required at a rate lower than that obtainable by the smallest possible pitch of either the ball channel or screw threads, the mechanism must be provided with a speed reducing means such as a gear train or the like, which increases the cost of manufacture as well as the size and weight of the unit.

Additionally, the objective of the Hogan patent is quite different than that of the present invention, as recited in column 1, lines 36 - 40 as follows:

It is therefore the main object of this invention to provide a device through which relatively high speed rotary motion of one driving member can be directly translated into extremely low speed linear motion of a driven member.

This objective is achieved in the Hogan patent with a ball friction drive having a ball screw and a nut device. The ball screw comprises a plurality of juxtaposed disk 28 and two end disks 29 and 30. Both external peripheral edges of the disks 28 as well as the opposed external peripheral edges of

the end disks 29 and 30 are beveled at a given angle. Each disk 28, as well as the opposed faces of the end disks 29 and 30, are shaped so that the peripheral inclined opposed edges 36 of each adjacent disk defines together a V-shaped helical groove 37 filled with balls 38 extending from this groove to cooperate with the driven member 34. Such a helical groove presents two ends constructed by a passageway 39. In this construction, when making one turn, a disk 28 moves axially for a very small distance that corresponds to the pitch of the screw. This is also very small and much smaller than the size of the balls 38 located in the helical group 37. As such, in the drive system of the Hogan patent, the pitch of the screw is defined by the two juxtaposed disks 28 or by one disk 28 and an end disk 29 or 30. It is not defined by two successive helical grooves 37 of the screw.

Contrary to the Examiner's arguments, if one with ordinary skill in the art modified the drive system of the Hogan patent to provide the inner wall of the driven member with a continuous helical ball race (such as that described in the Brusasco patent) for one helical groove of the screw in the Hogan patent, this ball race should adopt the very small pitch, as mentioned before. Since the drive system of the Hogan patent has a plurality of disks 28 and end disks 29 and 30 that define the plurality of ball races on the screw, any modification of the drive system of the Hogan patent, as suggested by the Examiner, would lead one to provide the inner wall of the driven member with as many ball races as the screw has. This would lead to a superposition of a plurality of ball races in which each has a very small pitch. This cannot be achieved, in any way, since there is not enough room on the inner wall of the driven member to provide this inner wall with such ball races.

Additionally, and as mentioned herein above, the movement of the driven member in the Hogan patent is generated by the tracking of this driven member because of the frictional interaction between the balls 38 and the driven member 34. In order to achieve such a frictional interaction, it

is necessary to bring the balls 38 into frictional contact with the driven member 34. This be achieved only by tightening the nut 24 so as to bring the disks 28, 29 and 30 closer together. When the disks are brought closer together, the nominal diameter of the ball races is increased so as to urge the balls radially against the inner wall of the driven member. The bringing of these disks together has another collateral effect causing the approaching of the balls of the successive ball races of the screw to change pitch. Such a changing of the pitch would imply that the balls of the ball race of the screw would not be able to cooperate with the ball race on the inner wall of the driven member that corresponds to the ball race of the screw when no changing of the pitch occurs.

As such, one must conclude that one having ordinary skill in the art would conclude that the very small pitch of the drive system of the Hogan patent would be completely incompatible with a plurality of ball races formed on the inner wall of the driven member. As such, it would not be possible to achieve the objectives of the present invention. As such, the Hogan patent actually teaches against the construction of the present invention as defined in independent Claim 53.

Even if one could imagine that a person with ordinary skill in the art would provide the inner wall of the driven member would continuous helical ball races that correspond to each ball race of the screw, this solution would go against the purpose of the teachings of the Hogan patent. One having ordinary skill in the art would encounter another problem. The balls of the different ball races of the screw would not cooperate with the same ball race of the inner wall of the driven member without having to adapt the distances between the ball races and the screw. As a result, Applicant respectfully contends that the Hogan patent and the Brusasco patent cannot be combined. This would create complete incompatibility between the essential features of the Hogan patent and the Brusasco patent. Fundamentally, one would never modify the Hogan patent so as to incorporate

the grooves on the inner wall of the outer tubular member of the Brusasco patent because complete incompatibility would occur. On this basis, Applicant respectfully contends that the present invention is non-obvious in view of the teachings of this prior art combination.

The Brusasco patent describes, in particular, a plurality of nuts that are provided each with a helical rolling groove having a different pitch, a screw having a shaft and a spring, and a plurality of balls cooperating with the rolling grooves of the spring and of the nuts. The spring is in the form of a spiral that is shaped to have concave coils defining a rolling groove in which the shaft is axially engaged. It must be observed that the shaft is freely engaged into the spiral spring. The spiral spring is able to adapt itself to the different pitch of the rolling grooves of the nut by expanding or retracting. This type of adaptation will lead to a modification of the pitch of the rolling groove of the spring. As such, the device disclosed in the Hogan patent and the Brusasco patent differ strongly from the present invention, as defined by independent Claim 53. Since the prior art combination teaches against each other and does not describe the structure of the present invention, Applicant respectfully contends that the present invention is non-obvious with respect to this prior art combination. As such, independent Claim 53 is patentably distinguishable from the prior art.

Dependent Claims 54 - 64 herein correspond, respectively, to the limitations found in previous dependent Claims 38 - 47. Dependent Claims 64 - 66 correspond, respectively, to the limitations found in previous dependent Claims 50 - 52.

Based upon the foregoing analysis, Applicant contends that independent Claim 53 is now in proper condition for allowance. Additionally, those claims which are dependent upon this independent claim should also be in condition for allowance. Reconsideration of the rejections and

allowance of the claims at an early date is earnestly solicited. Since no new claims have been added above those originally paid for, no additional fee is required.

Respectfully submitted,

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